VIII. "On the Lead-Zinc and Bismuth-Zinc Alloys." By A. Matthiessen, F.R.S., and M. von Bose. Received August 28, 1861.

The fact that lead and zinc, and bismuth and zinc do not alloy together in every proportion is well known, but there have been, we believe, no determinations made as to the extent in which these metals alloy with each other.

The following experiments were made to ascertain quantitatively what amount of zinc will dissolve in lead and bismuth, and, on the other hand, the amount of bismuth and lead in zinc.

The metals* were fused in a Hessian crucible over a 4-Bunsen burner, stirred with a tobacco-pipe stem for a quarter of an hour, and then allowed to remain quiet for half an hour in a fused state: during the whole time a jet of gas was directed on the surface of the melted metals. They were after this cast in a porous cell, which had been previously heated to redness in a large crucible filled with sand. It was generally about two hours before the metals became solid: in some cases the crucible was placed in a furnace with a low fire so as to cool much slower, but the separation of the metals did not appear to be more perfect than when cooled in the usual manner. When cold the cell was broken, and the top of the alloy separated from the lower part by a blow of the hammer.

The weight of each casting was about 300 grms., its height about 100 millims., and its diameter about 25 millims.

Lead-Zinc Alloys.

The Zinc-end.—About 12 grms. were taken from the middle of the end, avoiding the outside. The greater part of the zinc was dissolved in dilute hydrochloric acid, the residue dissolved in nitric acid and precipitated by sulphuretted hydrogen; the washed sulphide oxidized by fuming nitric acid, and the lead weighed as sulphate. Or, instead of precipitating by sulphuretted hydrogen, the mixed nitrates were precipitated by ammonia and carbonate of ammonia, and the lead weighed as oxide.

The Lead-end.—8 grms. were dissolved in nitric acid, precipitated by sulphuretted hydrogen, the filtrate evaporated almost to dryness,

* Purified as described in the Phil. Trans. 1860, p. 177.

and again treated with sulphuretted hydrogen; the zinc then thrown down by carbonate of soda and weighed as oxide.

Analyses of the Lead-zinc Alloys.

Lead 50 per cent., and zinc 50 per cent.		
	Found.	Per-centage.
Taken lead-end... 8·000 grm. Taken zinc-end ... 12·450 „	0·162 ZnO 0·164 PbO	1·62 Zn 1·22 Pb
Lead 66·6 per cent., and zinc 33·3 per cent.		
Taken lead-end... 8·000 grms. Taken zinc-end... 12·55 „	0·162 ZnO 0·162 PbO	1·62 Zn 1·20 Pb
Lead 4 per cent., and zinc 96 per cent.		
Top ..... 14·170 grms. Bottom ..... 19·850 „	0·247 PbO SO^3 0·340 „	1·20 Pb 1·17 „
Lead 96 per cent., and zinc 4 per cent.		
Top ..... 8·000 grms. Bottom ..... 8·000 „	1·63 ZnO 1·79 „	1·63 Zn 1·79 „

Bismuth-Zinc Alloys.

The Bismuth-end.—About 3 grms. were dissolved in nitric acid, evaporated with hydrochloric acid to destroy the nitric acid, precipitated by sulphuretted hydrogen, evaporated almost to dryness, and again treated with sulphuretted hydrogen; the zinc was lastly precipitated by carbonate of soda and weighed as oxide. The analyses marked (*) were made in the following manner:—The alloy was dissolved in nitric acid, diluted with water, and the bismuth precipitated by ammonia and carbonate of ammonia. The bismuth was filtered off and washed with a mixture of 10 parts water, 2 of ammonia, and 1 of carbonate of ammonia. The filtrate was mixed with carbonate of soda in excess, and evaporated down on a water-bath in a platinum dish; when dry, it was moistened with water and again evaporated to dryness in order to drive off the last traces of ammoniacal salts. The dry mass was then washed into a beaker, made slightly acid, boiled, and whilst boiling precipitated by carbonate of soda: the zinc was weighed as oxide.

The Zinc-end.—About 12 grms. were taken, the zinc partly dissolved out by dilute hydrochloric acid, the residue dissolved in nitric acid, and precipitated by ammonia and carbonate of ammonia: the bismuth was weighed as oxide.

Analyses of the Bismuth-zinc Alloys.

Taken.	Found.	Per-centage.
Bismuth 50 per cent., and zinc 50 per cent.		
Zinc-end ..... 15·520 grms.	0·420 BiO^3	2·42 Bi
Zinc-end ..... 13·990 „	0·386 „	2·48 „
Bismuth-end..... 8·000 „	1·385 „	13·85 Zn
Bismuth 50 per cent., and zinc 50 per cent.		
Zinc-end ..... 14·2042 grms.	0·3784 BiO^3	2·39 Bi
*Bismuth-end ... 3·5060 „	0·3795 ZnO	8·65 Zn
Bismuth 80 per cent., and zinc 20 per cent.		
Top ..... 2·990 grms.	0·525 ZnO	14·0 Zn
*Top ..... 3·0096 „	0·5295 „	14·1 „
Bottom..... 3·694 „	0·597 „	12·93 „
*Bottom..... 2·9758 „	0·4885 „	13·1 „
Bismuth 80 per cent., and zinc 20 per cent.		
*Top ..... 2·5542 grms.	0·5208 ZnO	16·3 Zn
*Bottom..... 2·5356 „	0·4206 „	13·3 „
Bismuth 80 per cent., and zinc 20 per cent.		
*Top ..... 2·5778 grms.	0·4548 ZnO	14·1 Zn
*Bottom..... 2·5757 „	0·2830 „	8·8 „
Bismuth 5 per cent., and zinc 95 per cent.		
Top ..... 13·230 grms.	0·351 BiO^3	2·38 Bi
Bottom..... 16·050 „	0·430 „	2·40 „

From the foregoing analyses, it appears that lead will, under the conditions detailed above, dissolve only 1·6 per cent. zinc, and zinc 1·2 per cent. lead; that zinc will only dissolve 2·4 per cent., bismuth 8·6–14·3 per cent.

If we now take equal parts of lead and zinc, fuse them together, stir them well, and cool the alloy rapidly, we may regard such an alloy as a mechanical mixture of solutions of 1·2 per cent. lead in

zinc, and 1·6 per cent. zinc in lead. And the same may be said of the bismuth-zinc alloys when fused together in proportions greater than those in which these metals dissolve in one another.

IX. "On some Gold-Tin Alloys." By A. Matthiessen, F.R.S., and M. von Bose. Received August 28, 1861.

It was observed in a former research* that the gold-tin alloys had a great tendency to crystallize, and it was deduced from results then obtained that some of them were chemical combinations. With a view to ascertain whether these would crystallize out from the fused metals, the following experiments were undertaken.

The metals† were weighed out in the proper proportions, and fused together in a crucible over a 4-Bunsen burner, a jet of gas playing on the surface from above to prevent the oxidation of the tin. When fused, the lamp was removed and the alloy allowed to cool (the jet of gas still playing upon it) until the surface began to solidify, when the liquid alloy was poured off from the crystals. Of course the two metals were always stirred well, and cast several times before the alloy was crystallized and analysed.

When the metals were fused together in the proportion to form $AuSn_2$ (62·9 per cent. Au) and $AuSn_3$ (53·1 per cent. Au), no crystals could be obtained in either case. When, however, more tin was added, so as to make the alloy $AuSn_4$ (45·9 per cent. Au), a separation took place into a non-crystalline mass with a glassy fracture and a very crystalline one: these may be easily separated from each other by fusion, for the former has a much higher fusing-point than the latter. The alloy containing 43·5 per cent. gold behaved in the same manner. The analyses of the different parts of these alloys are given in the following Table. The gold was determined by dissolving the alloy in nitro-hydrochloric acid, and precipitating the gold from the strong hydrochloric acid solution with sulphite of soda:—

* Phil. Trans. 1860. p. 170.

† These were purified as described in the Phil. Trans. 1860, p. 177.